ANTIMONY

FACT SHEET

See related Fact Sheets: Acronyms & Abbreviations; Glossary of Terms; Cost Assumptions; Raw Water Composition; Total Plants Costs; and WaTER Program.

1. CONTAMINANT DATA

A. Chemical Data: Antimony (Sb), atomic number: 51, atomic weight: 121.75, is a silvery-white, brittle, semimetallic element. Alloyed with other metals to increase their hardness and strength, also used as a fire retardant.

B. Source in Nature: Sb is found at very low levels throughout the environment, the general population is exposed to low levels of it everyday, primarily in food, drinking water, and the air. More Sb is found in food and air than water. Sb occurs in nature only in a combined state and found in over 100 mineral species. It is sometimes found native, but more frequently as the sulfide stibnite, and the trioxide, valentinite. Other ores include cervantite, livingstonite, jamisonite, and kermesite. Sb is also a common component of coal and petroleum. Industrial plants, auto emissions, and exhausts from oil fuels are the main sources of Sb in urban air, where it eventually finds its way to lakes and streams, adhering to the sediments. Sb trioxides are also released into the atmosphere by factories that convert antimony ores into metal by smelting, molding, and incineration of the Sb materials. Sb may appear in water from corrosion of lead pipes and fittings, but is rarely detectable.

C. SDWA Limits: MCLG/MCL for Sb is 0.006 mg/L.

D. Health Effects of Contamination: Sb, in short-term exposure levels above the MCL: gastrointestinal disorders, nausea, vomiting, and diarrhea can occur. Sb, when left on the skin can irritate it. In long-term exposures at levels above the MCL: decreased longevity, cardiovascular problems, and altered blood levels of glucose and cholesterol can be expected. Sb is beneficial when used for medical purposes. It has been used as a medicine to treat people infected with parasites. Sb is not known to be or classified as a carcinogen.

2. REMOVAL TECHNIQUES

A. USEPA BAT: Coagulation and filtration or reverse osmosis.

! Coagulation and filtration uses the conventional treatment processes of chemical addition, coagulation, and dual media filtration. Benefits: low capital costs for proven, reliable process. Limitations: operator care required with chemical usage; sludge disposal.

! RO for soluble Sb uses a semipermeable membrane, and the application of pressure to a concentrated solution which causes water, but not suspended or dissolved solids (soluble Sb), to pass through the membrane. Benefits: produces high quality water. Limitations: cost; pretreatment/feed pump requirements; concentrate disposal.

B. Alternative Methods of Treatment: Distillation (for home drinking water only), heats water until it turns to steam. The steam travels through a condenser coil where it is cooled and returned to liquid. The Sb remains in the boiler section. Alternately, solid block or precoated absorption filters made with carbon are certified to reduce Sb are available.

C. Safety and Health Requirements for Treatment Processes: Personnel involved with demineralization treatment processes should be aware of the chemicals being used (MSDS information), the electrical shock hazards, and the hydraulic pressures required to operate the equipment. General industry safety, health, and self protection practices should be followed, including proper use of tools.

3. BAT PROCESS DESCRIPTION AND COST DATA

General Assumptions: Refer to: Raw Water Composition Fact Sheet for ionic concentrations; and Cost Assumptions Fact Sheet for cost index data and process assumptions. All costs are based on *ENR*, PPI, and BLS cost indices for March 2001. General sitework, building, external pumps/piping, pretreatment, or off-site sludge disposal are not included.

Bureau of Reclamation, Technical Service Center
Water Treatment Engineering and Research Group, D-8230
PO Box 25007, Denver CO 80225 (303) 445-2260

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3A. Coagulation and Filtration:

Process - Coagulation and filtration for insoluble Sb uses the conventional chemical and physical treatment processes of chemical addition, rapid mix, coagulation with dry alum, flocculation, and dual media filtration. Chemical coagulation and flocculation consists of adding a chemical coagulant combined with mechanical flocculation to allow fine suspended and some dissolved solids to clump together (floc). $Al_2(SO_4)_3$ has been proven to be the most effective coagulant for insoluble Sb removal. Filtration provides final removal by dual media filtering of all floc and suspended solids.

Pretreatment - Jar tests to determine optimum pH for coagulation, and resulting pH adjustment, may be required.

Maintenance - A routine check of chemical feed equipment is necessary several times during each work period to prevent clogging and equipment wear, and to ensure adequate chemical supply. All pumps, valves, and piping must be regularly checked and cleaned to prevent buildup of carbonate scale, which can cause plugging and malfunction. Routine checks of contaminant buildup in the filter is required, as well as filter backwash. Recharging or clean installation of media is periodically required.

Waste Disposal - Filter backwash and spent material require approved disposal.

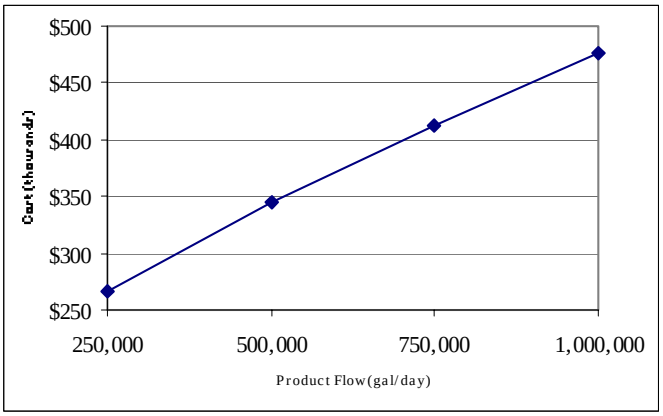
Advantages -

- ! Lowest capital costs.
- ! Lowest overall operating costs.
- ! Proven and reliable.
- ! Low pretreatment requirements.

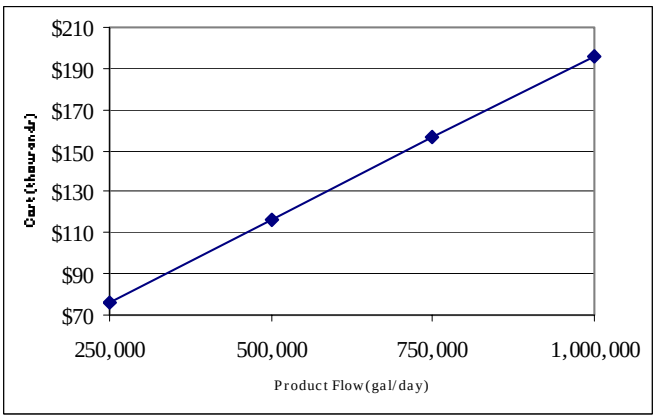
Disadvantages -

- ! Operator care required with chemical handling.
- ! Produces high sludge volume.
- ! Waters high in sulfate may cause significant interference with removal efficiencies.

BAT Equipment Cost*



BAT Annual O&M Cost*



*Refer to Cost Assumptions Fact Sheet. Does not include general sitework, building, external pumps/piping, pretreatment, or off-site sludge disposal. Costs are presented for direct filtration (coagulation and filtration plus flocculation). Costs for coagulation and filtration would be less since flocculation is omitted.

3B. Reverse Osmosis:

Process - RO is a physical process in which contaminants are removed by applying pressure on the feed water to direct it through a semipermeable membrane. The process is the "reverse" of natural osmosis (water diffusion from dilute to concentrated through a semipermeable membrane to equalize ion concentration) as a result of the applied pressure to the concentrated side of the membrane, which overcomes the natural osmotic pressure. RO membranes reject ions based on size and electrical charge. The raw water is typically called feed; the product water is called permeate; and the concentrated reject is called concentrate. Common RO membrane materials include asymmetric cellulose acetate or polyamide thin film composite. Common membrane construction includes spiral wound or hollow fine fiber. Each material and construction method has specific benefits and limitations depending upon the raw water characteristics and pretreatment. A typical large RO installation includes a high pressure feed pump, parallel 1st and 2nd stage membrane elements (in pressure vessels); valving; and feed, permeate, and concentrate piping. All materials and construction methods require regular maintenance. Factors influencing membrane selection are cost, recovery, rejection, raw water characteristics, and pretreatment. Factors influencing performance are raw water characteristics, pressure, temperature, and regular monitoring and maintenance.

Pretreatment - RO requires a careful review of raw water characteristics and pretreatment needs to prevent membranes from fouling, scaling, or other membrane degradation. Removal of suspended solids is necessary to prevent colloidal and bio-fouling, and removal of dissolved solids is necessary to prevent scaling and chemical attack. Large installation pretreatment can include media filters to remove suspended particles; ion exchange softening or antiscalant to remove hardness; temperature and pH adjustment to maintain efficiency; acid to prevent scaling and membrane damage; activated carbon or bisulfite to remove chlorine (postdisinfection may be required); and cartridge (micro) filters to remove some dissolved particles and any remaining suspended particles.

Maintenance - Monitor rejection percentage to ensure Sb removal below MCL. Regular monitoring of membrane performance is necessary to determine fouling, scaling, or other membrane degradation. Use of monitoring equations to track membrane performance is recommended. Acidic or caustic solutions are regularly flushed through the system at high volume/low pressure with a cleaning agent to remove fouling and scaling. The system is flushed and returned to service. $NaHSO_3$ is a typical caustic cleaner. RO stages are cleaned sequentially. Frequency of membrane replacement dependent on raw water characteristics, pretreatment, and maintenance.

Waste Disposal - Pretreatment waste streams, concentrate flows, and spent filters and membrane elements all require approved disposal.

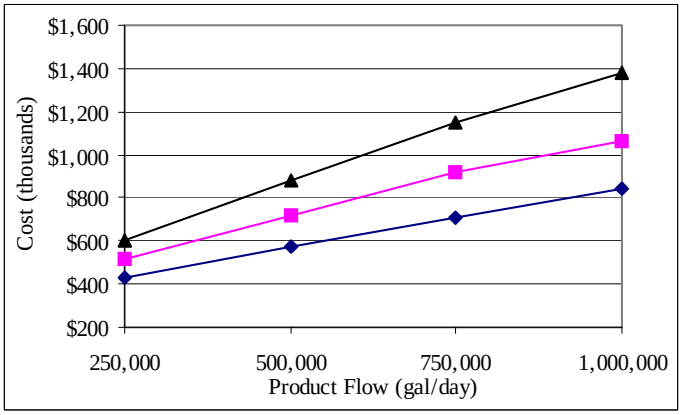
Advantages -

- Produces highest water quality.
- Can effectively treat wide range of dissolved salts and minerals, turbidity, health and aesthetic contaminants, and certain organics; some highly-maintained units are capable of treating biological contaminants.
- Low pressure (<100 psi), compact, self-contained, single membrane units are available for small installations.

Disadvantages -

- Relatively expensive to install and operate.
- Frequent membrane monitoring and maintenance; monitoring of rejection percentage for Sb removal.
- Pressure, temperature, and pH requirements to meet membrane tolerances. May be chemically sensitive.

BAT Equipment Cost*



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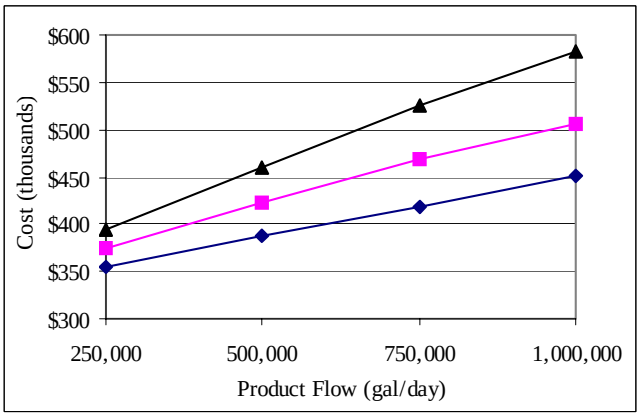

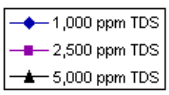

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